VXI Data Acquisition System Software v2.0
Statement of Work
W9124R05T0038 CLIN 0001

1.0 OBJECTIVE

The contractor shall deliver a software suite that will rapidly, accurately, and reliably perform functions necessary to gather a wide variety of data related to the testing of ballistic and non-ballistic weapon systems, munitions, and other military systems. These functions include but are not limited to initializing, configuring, arming, and triggering hardware as well as transferring, storing, displaying, analyzing, archiving, and manipulating data.

2.0 BACKGROUND

2.1 A primary mission of the U.S. Army Yuma Proving Ground (USAYPG) is the testing of military weapon systems and munitions. This type of testing requires the precise measurement of timing and engineering data. Measurements include, but are not limited to; firing time, chamber pressure, acceleration, strain, linear displacement, Blast Over-Pressure (BOP), impulse noise, and etcetera. Sensor locations are typically inside/on the gun-tube, inside/on the weapon chassis, or within 100 meters of the weapon.

2.2 The VXI Data Acquisition System (VXIDAS) with v1.xx software has been in operation at USAYPG for approximately seven years. The VXIDAS software is written in LabView, but OEM software is used for the Precision Filters signal conditioning racks. The primary acquisition hardware is VXI. The computer operating system was originally Windows NT 4.0 and is currently Windows XP Professional. The primary instrumentation interface is National Instruments' VXI-PCI8015 MXI-2. Sensor signal conditioners typically use Ethernet, PCI-MXI-2 (or 3), GPIB, or RS-232 interfaces for communication.

2.3 The system is typically used to collect data from the following types of sensors:

2.3.1	Interior Ballistics - Piezoelectric (charge mode) pressure gages	150 kPSI
2.3.2	Blast Over-Pressure – ICP/IEPE (constant current) pressure gages	200 PSI
2.3.3	Ballistic Shock – Piezo-resistive accelerometers	+/-200 kG
2.3.4	Strain - Axial and Rosette strain gages	+/-150,000 uE
2.3.5	Noise / Acoustics - B&K Microphones w/Nexus Amplifier	+/-1 PSI
2.3.6	Displacement – TempoSonics Transducer	+/-100 Inches
2.3.7	Timing Signals – Voltage	+/-15 Volts

3.0 SCOPE

3.1 Software Development

This project requires the contractor to develop a comprehensive software package using the latest capabilities provided by modern programming languages.

3.2 System Integration

This project will require the contractor to integrate various hardware platforms using several communication busses into a complete data acquisition system.

3.3 Hardware Engineering

No hardware engineering support shall be required as part of this project.

3.4 Hardware Fabrication

No hardware fabrication support shall be required as part of this project.

4.0 GENERAL REQUIREMENTS

4.1 The software shall interact with all hardware, as necessary, to ensure that the system as a whole is appropriately configured for testing. The software shall be structured to allow for the possibility of future addition of new hardware (VXI/PXI/GPIB/Serial/Etc) or new analysis routines/algorithms.

4.2 Rights to use any or all parts of the software developed by the Contractor shall be open and unrestricted for the Contractor and YPG. Dissemination of Government Furnished Information (GFI) shall be restricted.

4.3 Any element of this document may be waived at the option of YPG if YPG judges the contractor has a superior proposal or implementation. The government is open to all suggestions pertaining to the design, development or feature set of this software suite.

4.4 Operating System

The operating system to be utilized for this application will be Microsoft Windows XP Professional.

4.5 Programming Language/References

4.5.1 The programming language shall be the most recent release of LabView available at the time of contract award. The contractor shall provide their

own copy of LabView , and any toolsets/toolkits necessary, for the development of this software.

4.5.2 The source code shall be fully documented to the best commercial standards.

4.5.3 The "Call Library Function" and "Code Interface Node" (CIN) shall be used only on a case-by-case basis as approved by YPG technical representatives.

4.5.4 The contractor shall develop the software in accordance with the best commercial standards and best practices contained in the following references:

http://www.ni.com/pdf/manuals/321393d.pdf#labview_style_guide
http://www.bloomy.com/resources/five_techniques_for_better_labview_code.pps
http://www.bloomy.com/resources/labview_style_guidelines.pps

5.0 FUNCTIONAL REQUIREMENTS

5.1 Help

The software shall contain a complete help subsystem to explain the function and options of each control or indicator. The help windows shall also show the minimum, maximum, and default value for each control if appropriate for the type of control.

5.2 Default System Settings

5.2.1 The system shall maintain a variety of settings that will determine how the system acts or presents data. These settings shall be maintained in such a manner as to allow or restrict access to designated individuals and/or groups. This information shall be stored as a file on the local system and the local system shall check for latest version availability, from a remote server, during system start-up. A separate utility shall be provided to create or edit these files.

5.2.1.1 Remote server address

5.2.1.2 Default Settings for all controls

5.2.1.3 Default data paths for local and archive storage

5.2.1.4 Default Analysis Settings –
Fast Fourier Transformation (FFT)
Power Spectrum

5.2.1.5 Spike detection criteria – Minimum slope (Volts/Second)

5.2.1.6 Valid data client address extensions/masks - *.yuma.army.mil, *.army.mil, *.mil, or etcetra. Name or IP

5.2.1.7 PE (Project Engineer) name list

5.2.1.8 Retry attempts for archiving data before operator notification / failure log entry

5.2.1.9 Normalization enabled or disabled for all channels

5.2.1.10 Normalization algorithm

5.2.1.11 Test Mode Pass / Fail Criteria

5.3 System Initialization

5.3.1 The software shall be capable of interactively controlling the following hardware:

5.3.1.1	VX1410A/20A	Tektronix VXI Intelliframe
5.3.1.2	VX4244	Tektronix 16 Channel Digitizer
5.3.1.3	VX4780	Tektronix 16 Channel Signal conditioner
5.3.1.4	V200	KineticSystems 16/32 Channel Digitizer
5.3.1.5	28000	Precision Filters Inc. Mainframe
5.3.1.6	PF27104& 28104	PFInc Quad Bridge Conditioner
5.3.1.7	PF27304	PFInc Quad Charge/IEPE Amplifier
5.3.1.8	PF28134	PFInc Quad WB Bridge Conditioner
5.3.1.9	PF28316A	PFInc 16-Channel IEPE Conditioner
5.3.1.10	PF28334	PFInc Quad WB Charge/IEPE Amplifier
5.3.1.11	PF28454	PFInc Quad Balanced Current Conditioner
5.3.1.12	Bc637PCI	Symmetricom PCI GPS Receiver
5.3.1.13	HP34401A	Hewlett-Packard Multimeter
5.3.1.14	HP33220A	Hewlett-Packard Function/Arbitrary Gen.
5.3.1.15	DS335	Stanford Research Synthesized FuncGen
5.3.1.16	6115G-TSM	ITS GPS Timing Subsystem

5.3.2 System hardware inventory / availability – The software shall scan for available instrumentation to create a resource list of equipment ready for use. The scan shall identify all available instrumentation listed above on the Serial, GPIB, VXI, and PCI busses. The software shall also scan the

network for the Precision Filters 28000 mainframes and the ITS 6115G-TSM (www.itsAmerica.com).

5.3.3 Dynamic address allocation/assignment shall be used wherever possible.

5.3.4 A display for network access, status, and the presence/access to the data storage archive shall be visible at all times.

5.3.5 The software shall support linking multiple VXI and Precision Filters mainframes.

5.4 System Timing. The system timing source shall be used as the primary timing reference for synchronizing and time stamping all data products. The system operator shall be capable of selecting the most appropriate time source of those available at system startup. The system shall use UTC and provide the operator the capability of correcting to the Local time zone. Data products shall be annotated to the best resolution of the source selected. The resolution of the timing source shall also be annotated in all data files. The software shall synchronize the computer clock to the selected timing source.

5.4.1 Available Timing sources and precedence of use:

5.4.1.1	Instrumentation Technology Systems (ITS) Timing Box	1st
5.4.1.2	Bc637PCI GPS Card	2nd
5.4.1.3	Network Time Server	3rd
5.4.1.4	System Clock	4th

5.4.2 The software shall support time tagging of data for the following trigger modes:

5.4.2.1 External Trigger Mode – A trigger pulse will be provided to the ITS Box, GPS Card, and the external trigger circuit of the digitizer board(s). The software shall provide for name entry for time zero source such as “shotgun”, “muzzle exit”, or “firing pulse” etcetera.

5.4.2.2 Data Trigger Mode – The system will be triggered based on a threshold detection from the designated trigger channel(s). No trigger pulse will be provided to the ITS Box, GPS Card, or the external trigger circuit of the digitizer board(s).

5.4.3 A Time/Source/Status display shall be visible at all times.

5.5 Header/Test Information

5.5.1 Administrative Information – This information is typically set at the beginning of the test and not changed frequently during the test. The operator will need occasional access to this information during testing.

5.5.1.1 Technician Name – Pull user name from login

5.5.1.2 Project Engineer Name – Select from name list

5.5.1.3 Schedule Request Number(SR#) – Alpha-Numeric designation

5.5.1.4 Job Order Number (JONO#) – Alpha-Numeric designation

5.5.1.5 Army Decision Support System# (ADSS#) – Alpha-Numeric designation

5.5.1.6 Project Name – Alpha-Numeric designation

5.5.1.7 Test Location – Alpha-Numeric designation

5.5.1.8 Data Classification – All data graphs and plots shall display the data classification at the center of the top and bottom of the graph or plot. The software shall mark all data and data files with one of the following security classifications:

5.5.1.8.1 Top Secret
5.5.1.8.2 Secret
5.5.1.8.3 Confidential
5.5.1.8.4 Unclassified (Default)
5.5.1.8.5 Proprietary

5.5.2 Weapon Information – The operator must have ready access to this information during testing as it will change frequently.

5.5.2.1 **Tube Round#** – The control for the next Round# shall be available at all times. The Round# shall auto-increment after every triggered acquisition without operator intervention. The Round# shall be manually adjustable by the operator. Under no circumstance shall changing the Round# cause data to be overwritten. The Round# is the primary piece of information used to administratively coordinate test data secondary is time and date of firing.

5.5.2.2 Weapon Model – Alpha-Numeric designation

5.5.2.3 Tube Serial # – Alpha-Numeric designation

5.5.2.4 Propelling Charge – Alpha-Numeric designation

5.5.2.5 Propellant Temperature – Numeric

5.5.2.6 Projectile Type – Alpha-Numeric designation

5.5.2.7 Projectile Temperature – Numeric

5.5.2.8 Weapon Quadrant Elevation(QE)(mils) – -300 to +1600

5.5.2.9 Weapon Traverse(mils) – 0(Center)(Default), -3200 to +3200

5.6 Configuration

5.6.1 Channel Number/Name – A combined reference shall be used. The number shall be derived from the hardware location and the name will be input by the operator. The name will identify the location and orientation of the sensor if the orientation of the sensor is a significant factor. The digitizer channel number shall be formatted as Ch001-ChXXX.

5.6.2 Channel Types – The channel type will determine what type of basic analysis may be used for each channel. The capability to enable or disable the specified analysis shall be provided on a channel by channel basis. The software shall support the following channel types as a minimum:

	Channel Type	Basic Analysis Type
5.6.2.1	Pressure	Ignition Delay, Rise Time
5.6.2.2	Muzzle Exit	Muzzle Exit Delay
5.6.2.3	Accelerometer	Integral(s) for Vel./Displ.
5.6.2.4	Strain	Principal Strains & Stresses w/Angle
5.6.2.5	BOP Gage	BOP Algorithm(GFI)
5.6.2.6	BOP Microphone	BOP Algorithm (GFI)
5.6.2.7	Displacement	Derivative(s) for Vel./Accel.
5.6.2.8	Force	Min, Max
5.6.2.9	Voltage	Min, Max
5.6.2.10	Microphone Calibration	Mic Cal Algorithm (GFI)

5.6.3 Channel Invert – The software shall provide the capability to invert a channel (multiply by –1) on a channel by channel basis. Inversion will be enabled or disabled by the operator based on the needs of the test.

5.6.4 Gage Factor Input – The software shall be capable of accepting gage factors provided in the following formats:

5.6.4.1 Single point (slope) Volts/EU
5.6.4.2 slope/intercept
5.6.4.3 multi-point

5.6.5 Gage Factor Input (TEDS) – The software shall be capable of accepting gage factors provided by Transducer Electronic Data Sheet (TEDS) Transducers using signal conditioners in the hardware list that are TEDS capable.

5.6.6 Gage Factor Units – PSI, kPa, Bars, volts, uE (micro-strain) or etcetera.

5.6.7 Young's Modulus – Input for strain gage channels used to calculate Stresses.

5.6.8 Display/Output Units – The engineering units the data will be scaled in. PSI, kPa, Bars, lbs., Newtons, volts, uE (micro-strain) or etcetera.

5.6.9 Normalization – The software shall provide the capability to automatically compensate for offset bias of the input signal. The software shall apply the normalization algorithm (GFI) to the channels for which it is selected. Normalization will be enabled or disabled, on a channel by channel basis, by the operator based on the needs of the test.

5.6.10 Triggering – The software shall exploit all triggering modes available in the digitizers.

5.6.10.1 Threshold
5.6.10.2 Level
5.6.10.3 Slope
5.6.10.4 Source
5.6.10.5 VXITTL lines(Master/Slave)
5.6.10.6 External

5.6.11 VXITTL line usage

5.6.11.1 Master Trigger Groups – The software shall support the creation of multiple Master Trigger Groups. When the master trigger group triggers it will strobe a previously configured VXITTL line.

5.6.11.2 Synchronization – The software shall support the slaving of trigger groups to Master Trigger Groups. The slaved group will monitor a previously configured VXITTL line and trigger when that line is strobed.

5.6.12 Math Channels/Multi-Channel Analysis: Use one or more hardware channels to produce a resultant "Math" channel. Math functions shall include product, quotient, sum, difference, integral, and derivative. Once a math channel is created it shall be added to the list of channels available to create other math channels.

5.6.13 Handle active channels/trigger channels hardware limitations – The software shall prevent the use of invalid hardware configurations. For example, the VX4244 does not allow the use of three active channels in a four channel group.

5.6.14 The software shall provide Preview windows in setup mode to display continuous scaled ambient data for the channels that are being configured at that time.

5.6.15 The software shall provide the capability to page back and forth through the configuration pages, committing changes to evaluate effect on ambient data in the Preview windows

5.6.16 As a minimum, during configuration, the software shall display:

5.6.16.1 Maximum available ceiling in Engineering Units(EU)
5.6.16.2 Input step resolution in EU
5.6.16.3 Pre-Trigger Time, Post-Trigger Time, and Total Capture Time
5.6.16.4 Trigger level in Volts for External and EU for Threshold
5.6.16.5 Other settings as necessary to control the complete feature set of the hardware

5.6.17 Mass versus group versus individual channel setup – The software shall provide the capability to quickly perform channel setup for all channels, individual modules, individual groups, or individual channels.

5.6.18 Display Groups – The software shall provide the capability of grouping channels for later display in a single window. Add channels to a series of "display groups" to allow viewing stacked or overlapped data traces. The operator shall have the capability to select whether to stack or overlap traces in the Data Viewer.

5.6.19 Calibration database functionality (SQL) (format provided as GFI)Read gage factor based on serial number and model number. Check against limits for gage type.

5.6.20 Limit Checking/Violation – The software shall be capable of performing limit checking/violation. The operator will enable, disable, and set limits by channel. After data for a measurement is stored the software shall

check the data channels for limit violations and notify the operator if any violations have occurred.

5.6.21 Configuration save, save as, and reload capability

5.7 Acquisition

5.7.1 Transient Acquisition Mode

5.7.1.1 The software should provide Thumbnail Displays-4 traces by 4 windows while writing next digitizer's data set to disk.

5.7.1.2 The software shall provide a Read-Again feature for data sets where data transfer from the digitizers is not completed properly or the computer suffers a failure.

5.7.2 Burst Mode – The software should provide the capability to perform burst measurements.

5.7.3 Arming

5.7.3.1 The software shall synchronize all acquisition clocks during the arming process.

5.7.3.2 If applicable to the digitizer, the software shall zero the memory during arming.

5.8 Storage/Archiving

5.8.1 Data file storage structure shall be uniquely identified so as to preclude the possibility of data being overwritten.

5.8.2 Data formats shall maintain backward compatibility with previous versions (if any)

5.8.3 Raw data shall be stored in a binary format. All configuration data shall be stored in the data files to allow the data to be transferred to platform independent storage formats such as HDF and databases such as Oracle.

5.8.4 Hardware tracking/association with data – Complete information regarding each channel shall be stored with the data from that channel. The information shall be sufficient to re-create the channel path including module type and serial numbers.

5.8.5 All data for each test round may be stored in a single file

5.8.6 Data shall be stored locally and at a pre-selected remote archive location (as processing time and network access permit). Absolute priority shall be given to storing data to the local machine. Archiving activity shall be automatic and include an activity monitor to ensure all data is copied and alert the operator of stoppages or archiving failures.

5.8.7 The software shall annotate data files and data products whenever overloads or spikes occur on a channel.

5.9 Data Display

5.9.1 The software shall be capable of displaying the timing information for the x-axis of the data display by system time or relative to trigger. This setting will be determined by operator selection.

5.9.2 The software shall allow the operator to perform live filtering of data using various digital filters – Low Pass, High Pass, Band Pass, Band Stop; Bessel, Butterworth, Chebyshev, Inverse Chebyshev, Elliptical, smoothing(2, 5, 10, 20… etc. Point)

5.9.3 Cursors – The software shall provide the capability to enable, disable, and add/remove cursors in display graphs. Cursors shall be pre-placed on the following points for each channel type:

5.9.3.1	Pressure	Min, Max, Zero Ignition Delay
5.9.3.2	Differential	Min, Max, Zero MaxNegbeforeBreech
5.9.3.3	Muzzle Exit	Muzzle Exit Time
5.9.3.4	Accelerometer	Min, Max, Zero
5.9.3.5	Strain	Min, Max, Zero
5.9.3.6	BOP Gage	Min, Max, Zero L+, L- FirstRise A-Duration B-Duration
5.9.3.7	BOP Microphone	Min, Max, Zero L+, L- FirstRise A-Duration B-Duration
5.9.3.8	Displacement	Min, Max, Zero
5.9.3.9	Force	Min, Max, Zero
5.9.3.10	Voltage	Min, Max, Zero

5.9.3.11	Microphone Calibration	Min, Max, Zero

5.9.4 The software's GUI should take advantage of menu based operations and key navigation to reduce screen clutter.

5.9.5 Display Groups – The software shall provide the capability of displaying comparable related data channels on a single graph. These channels will have been selected as a display group during configuration. They will typically be channels from a multi-channel sensor such as a tri-axial accelerometer, a strain gage rosette, or just channels that should provide similar data.

5.9.6 The software shall provide the capability to add and remove channels displayed on a data display graph to allow for comparison of multiple channels.

5.9.7 The software shall provide a histogram display when viewing each channel to monitor data trending for the current test mission

5.9.8 The software shall provide displays for first and second integrals for accelerometers (velocity and displacement) if enabled

5.9.9 The software shall provide displays for first and second derivatives for linear displacement transducers (velocity and acceleration) if enabled

5.9.10 The software shall provide BOP algorithm results in the data display and place cursors on significant points listed above.

5.9.11 The software shall provide indications of overload and spike detection in the data display.

5.9.12 The software shall provide the system settings and information that were used when the data was collected in a separate pop-up window.

5.10 Analysis

The software shall provide the following types of analysis.

5.10.1 Blast Over-Pressure (BOP) Algorithm (provided as GFI)

5.10.2 Validity checking of BOP test groups – The software shall evaluate whether 3 or 5 round groups are considered "good" groups. A group is considered "good" if the dB spread is less than the number of rounds fired. This check is performed for each channel. If the dB spread is greater than the number of rounds fired then another round must be fired. This process is repeated until the dB spread is less than the number of round fired.

5.10.3 Principal Strains and Stresses for rectangular and delta configuration rosette strain gages.

5.10.4 Shock Response Spectrum (SRS) – Smallwood Algorithm
5.10.4.1 Frequency Resolution- 1/N octave (1/12th default)
5.10.4.2 Damping Ratio - .05(default)
5.10.4.3 Results Format
5.10.4.3.1 1 -- positive primary
5.10.4.3.2 2 -- negative primary
5.10.4.3.3 3 -- absolute maximum primary
5.10.4.3.4 4 -- positive resisual
5.10.4.3.5 5 -- negative residual
5.10.4.3.6 6 -- absolute maximum residual
5.10.4.3.7 7 -- largest of 1&4, maximum positive
5.10.4.3.8 8 -- largest of 2&5, maximum negative
5.10.4.3.9 9 -- maximax, the largest absolute value of 1-8
5.10.4.3.10 10 -- returns 1&2 graphed together
5.10.4.3.11 11 -- returns a matrix s(9,length(fn)) with all the types 1-9

5.10.5 Joint Time-Frequency Analysis (JTFA)

5.10.6 FFT Analyzer – FFT, Inverse FFT, FHT, Inverse FHT

5.10.7 Integrate acceleration to get velocity and displacement

5.10.8 Differentiate displacement to get velocity and acceleration

5.11 Error Handling/Notification

The software shall provide fault detection/tolerance for all system operations.

5.12 Reporting

5.12.1 Tabular data (trace Min and Max) shall be presented in an Excel workbook. The data will be sorted by channel type with each type having it's own worksheet. A filtering option shall be provided that will produce additional columns which contain the Min and Max of the filtered traces. The software shall support the capability of presenting multiple sets of filtered data.

5.12.1.1 Breech and Chamber Pressure
5.12.1.2 Differential Pressure

5.12.1.3 Ignition Delay
5.12.1.4 Rise Time
5.12.1.5 T4 Time (Muzzle Exit Delay re: Fire Pulse)
5.12.1.6 Blast OverPressure
5.12.1.7 Strain
5.12.1.8 Accelerometer
5.12.1.9 Displacement

5.12.2 BOP Algorithm failure – The software shall check for BOP algorithm failures, report in Error worksheet.

5.12.3 Spike detection – Based on slope, report in Error worksheet.

5.12.4 Overload detection – in signal conditioner(s) and/or digitizer; report in Error worksheet.

5.13 Data Conversion
The software shall perform the following functions.

5.13.1 Convert data to ASCII – One column ASCII with header or two column ASCII with time and EU columns as a minimum. A filtering option shall be provided that will produce additional files which contain filtered ASCII data.

5.13.2 Generate SRS Data – Allow generation of a variety of formats (see 5.10.4) selectable by operator.

5.13.3 Post-processing – Produce Math channels as a post test function.

5.14 Data Editing/Correction
The software shall perform the following functions.

5.14.1 Software setting changes – by individual file or mass change by folder with recursive capability.

5.14.2 Hardware setting changes – The software shall make NO PROVISION for changing any hardware setting (gain, filtering, or etcetera) after the data has been collected.

5.15 Ethernet Access
The software suite shall provide utilities to perform the following functions. The software shall provide security to maintain limited and controlled access.

5.15.1 Ethernet Control/Display – The software shall allow the operator to exercise complete remote control capability of the system.

5.15.2 Ethernet Data Client
A client data viewer shall be provided that will allow remote users to view and evaluate the data. The viewer shall have a minimum of three modes:

5.15.2.1 QuickView mode – The viewer will display the thumbnail quick plots while writing the next digitizer's data to disk.

5.15.2.2 Passive Mode – The client will reflect the data the system operator is currently viewing.

5.15.2.3 Active Mode – The client will view data from the test data storage files.

5.16 System Diagnostics / Calibration
The following functions shall be integrated into the software. The will be executed under operator control.

5.16.1 The software shall make the most of Built In Test (BIT) capabilities of all hardware.

5.16.1.1 The software shall support all System Test Modes (STM) (Appendix A):

5.16.1.2 The software shall perform calibration routines on the Precision Filters Subsystem comparable to the Precision Filters Factory Acceptance Test (FAT). The testing/calibration routine shall be scalable to select only specific tests to run.

5.17 Operator Interface

5.17.1 The operator interface shall be designed to provide the operator with the maximum amount of system control and flexibility, while minimizing screen clutter.

5.18 System Operations

5.18.1 The software shall be designed to expedite the conduct and configuration of large channel count tests – up to 256 channels.

5.18.2 The software shall be capable of performing all functions when an operator is logged on with a standard USER account.

6.0 DELIVERABLES

6.1 Software The Contractor shall furnish four copies of all software code and associated files to YPG for its use, duplication, or modification as needed. The Contractor shall furnish YPG with four packages of an installable version of the software.

6.2 Manuals The Contractor shall provide three operators manuals for the system and two in depth system manuals. The manuals shall be of the best commercial standard. The manuals shall be provided as hardcopy and electronically as part of the software CD.

6.3 Training The Contractor shall provide on-site training at YPG for four personnel. This training shall use the concept of "train the trainer". The training shall include a certification process to show that the YPG personnel understand the functionality of the system. The training and certification should take place immediately after system acceptance.

7.0 DESIGN PLAN AND REVIEWS

7.1 The contractor shall provide a comprehensive design plan for software development. The Contractor shall develop a design review schedule including project milestones and milestone meetings. The following review schedule is proposed as a basic template:

7.1.1 Preliminary Design Review @ YPG – Discuss specific details of software, Contractor personnel witness current test operations, introduction to test hardware

7.1.2 2nd Design Review @ ?? – Review and Discuss GFE/GFI, Review Flowchart/Outline of O/A Design Approach & Features, Finalize Design Plan

7.1.3 100% Design Review @ ?? or via phone – Review progress, All GUI forms, Make Final Changes

7.1.4 Final Design Review @ Plant – Full Demonstration, Make any last minute changes pre-delivery

7.1.5 Acceptance and Final Evaluation @ YPG – Full Demonstration, Perform Mock Test Setup, Evaluate all functions and performance

Appendix A

The Use of Test-Modes for Measurement System Verification/Validation

The Precision Filters signal conditioning equipment has many special hardware features that may be utilized for system verification and validation. The Test-Modes setup the system in order to perform specific verifications on the measurement system hardware and connected transducers and cables that otherwise would be difficult (time consuming) or impossible to do. The Test-Modes will have a substantial impact on system life cycle costs by making time-consuming manual verification and validation routines automated. The user of the measurement system will be able to provide the customer with documented proof that the measurement system is within specification and that the noise levels are under control.

Rapid and powerful measurement system diagnostic capabilities can be provided by the utilization of the Test-Modes along with the measurement capability of the data acquisition system. Limits may be set in the acquisition computer to flag any out of tolerance channel.

A description of available Test-Modes for the various signal conditioner cards are as follows:

27104A/28104/28134 Bridge Conditioner Test-Modes		
Test-Mode	Description	Purpose
RUN	This is the operate mode for a channel. All channel parameters are under program control.	When the channel is returned to RUN from any Test-Mode, the previously set parameters are restored.
Test Bus	A switch at the amplifier input disconnects the sensor and substitutes the signal on the Test Bus. The Test Bus is an analog bus in the 28000 system that is common to all channel inputs. An external calibration signal can be applied via a BNC connector at the chassis front panel.	Inject calibration signals to channel inputs for purposes of verifying measurement system performance.
Amplifier Short	A switch disconnects the input from the transducer and shorts the input to ground.	Verify/document signal conditioner and digitizer noise levels.
Excitation Off	Sets the excitation voltage to zero	Verify that transducer self generated noise levels and noise pickup in the cables is sufficiently low.
Excitation Monitor	Connect the excitation supply across the differential amplifier input. The channel is DC coupled. The excitation voltage is measured by connecting the input amplifier through a precision resistor divider with a gain of x1/2. The input amplifier is set to a gain of Fsout/10V. Note: Gain of x1/2 is used because the excitation voltage can be programmed to levels that exceed that amplifier input range.	Verify excitation voltage through the amplifier.
Shunt Calibration	Precision bipolar voltage is inserted via precision resistors that are connected to the bridge corners. 4096 steps of shunt calibration are provided. Single shunt of any bridge arm or double shunt of opposing arms is supported.	Verify resistance of all bridge arms. Verify system DC span and linearity.
Output Monitor	The monitor bus is an analog bus available in the 28000 chassis and is used to view channel outputs. A switch at the output of each channel allows for a multiplexed connection to the monitor bus. Note: The normal signal path is not interrupted by the monitor function.	View analog output levels prior to the digitizer.

28454 Dynamic Strain Conditioner Test-Modes		
Test-Mode	Description	Purpose
RUN	This is the operate mode for a channel. All channel parameters are under program control.	When the channel is returned to RUN from any Test-Mode, the previously set parameters are restored.
Test Bus	A switch at the amplifier input disconnects the sensor and substitutes the signal on the Test Bus. The Test Bus is an analog bus in the 28000 system that is common to all channel inputs. An external calibration signal can be applied via a BNC connector at the chassis front panel.	Inject calibration signals to channel inputs for purposes of verifying measurement system performance.
Amplifier Short	A switch disconnects the input from the transducer and shorts the input to ground.	Verify/document signal conditioner and digitizer noise levels.
Excitation Off	Set the excitation current to zero	Verify that transducer self generated noise levels and noise pickup in the cables is sufficiently low.
IDRIVE	Connect the differential amplifier input across a precision 100 Ohm 0.01% 1ppm resistor on the DRIVE side current loop. The channel is DC coupled.	Verify DRIVE excitation current with the transducer connected through the amplifier. Data acquisition system can record all dynamic strain excitation currents simultaneously.
ISINK	Connect the differential amplifier input across a precision 100 Ohm 0.01% 1ppm resistor on the SINK side current loop. The channel is DC coupled.	Verify SINK excitation current with the transducer connected through the amplifier. Data acquisition system can record all dynamic strain excitation currents simultaneously.
Loop Resistance	The excitation current is programmed to 1mA. The amplifier is DC coupled. The channel gain is set to 1.	Verify transducer + cable resistance. Loop-Resistance verification can be run prior to a test, during a test or after the test.
AC Dither	An AC current is summed with the DC excitation current to simulate an AC stimulus through the transducer. The reference to the AC current is provided by the signal on the Test Bus. 100uA of current is supplied per V on Test Bus.	Verify end to end frequency response of measurement system, including cables. Verify system span.
Output Monitor	The monitor bus is an analog bus available in the 28000 chassis and is used to view channel outputs. A switch at the output of each channel allows for a multiplexed connection to the monitor bus. Note: The normal signal path is not interrupted by the monitor function.	View analog output levels prior to the digitizer.

27334 Dual Mode Charge/IEPE Conditioner Test-Modes		
Test-Mode	Description	Purpose
RUN	This is the operate mode for a channel. All channel parameters are under program control.	When the channel is returned to RUN from any Test-Mode, the previously set parameters are restored.
Test Bus	A switch at the amplifier input disconnects the sensor and substitutes the signal on the Test Bus. The Test Bus is an analog bus in the 28000 system that is common to all channel inputs. An external calibration signal can be applied via a BNC connector at the chassis front panel.	Inject calibration signals to channel inputs for purposes of verifying system performance.
Amplifier Short	A switch disconnects the input from the charge converter (charge mode) or the IEPE transducer (IEPE mode) and shorts it to ground.	Verify/document signal conditioner and digitizer noise levels.
Excitation Off (IEPE Mode Only)	Set the IEPE Current to zero	Verify that transducer self generated noise levels and noise pickup in the cables is sufficiently low in IEPE mode.
AC Current	Modulate the IEPE current with the signal on the test bus. AC current level is 100uA per volt on the test bus	Verify transducer cabling and output impedance. Signal generated as if it comes from the transducer itself.
Shunt Calibration (Charge Mode Only)	A test signal is inserted to the charge converter input through a precise capacitor.	Verify charge converter gain.
Output Monitor	The monitor bus is an analog bus available in the 28000 chassis and is used to view channel outputs. A switch at the output of each channel allows for a multiplexed connection to the monitor bus. Note: The normal signal path is not interrupted by the monitor function.	View analog output levels prior to the digitizer.

Suggested Verification/Validation Tests to be Performed Prior to Running the Actual Test

For 27104A/28104/28134:

1. Excitation Check: Set the amplifier to Test-Mode "EXC" and record the DC excitation voltage on each channel. The measured excitation voltage shall be compared to Yuma specified limits for pass/fail criteria.
2. AC Gain/Bandwidth Check: Set Test-Mode to "Testbus". Apply signal to the testbus input at the programmed cutoff frequency of the filter and measure the AC gain at the channel output. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level. Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.
3. DC Gain Check: Set Test-Mode to "Testbus". Apply DC signal to testbus and measure the DC gain of the channels. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level. Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.
4. Shunt Calibration Check: Set up conditioner for single shunt of R1 at user specified level. Set Test-Mode to "SHUNT". Measure DC voltage at the output and compare to Yuma specified limits. Repeat procedure for R2, R3 and R4.
5. DC Offset Check: Set Test-Mode to "Short". Measure DC offset at channel output. The measured offset shall be compared to Yuma specified limits for pass/fail criteria.
6. DC Zero Check (after auto-balance w/ transducer connected): Set Test-Mode to "RUN". Measure DC offset at channel output. The measured offset shall be compared to Yuma specified limits for pass/fail criteria.
7. Noise Check Input Short: Set Test-Mode to "Short". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.
8. Noise Check Excitation Off: Set Test-Mode to "EXC Off". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.

For 28454:

1. Excitation Check: Set the amplifier to Test-Mode "IDRIVE" and record the DC excitation current on each channel. The measured excitation voltage shall be compared to Yuma specified limits for pass/fail criteria.
2. Excitation Check: Set the amplifier to Test-Mode "ISINK" and record the DC excitation current on each channel. The measured excitation voltage shall be compared to Yuma specified limits for pass/fail criteria.
3. AC Gain/Bandwidth Check: Set Test-Mode to "Test bus". Apply signal to the test bus input at the programmed cutoff frequency of the filter and measure the AC gain at the channel output. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level.

Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.

4. Loop Resistance Check (w/ transducer connected): Set Test-Mode to "Loop Resistance". Measure DC voltage at the channel output. Loop resistance = 1 Ohm per mVdc. The measured loop resistance shall be compared to Yuma specified limits for pass/fail criteria.
5. AC Calibration Check/Cable & Transducer Check: Set Test-Mode to "AC Current". Apply signal to the Test Bus input at the programmed cutoff frequency of the filter and measure the AC gain at the channel output. AC current level is 100uA/V of test bus signal. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level. Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.
6. DC Zero Check (w/ transducer connected): Set Test-Mode to "RUN". Measure DC offset at channel output. The measured offset shall be compared to Yuma specified limits for pass/fail criteria.
7. Noise Check Input Short: Set Test-Mode to "Short". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.
8. Noise Check Excitation Off: Set Test-Mode to "EXC Off". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.

For 28334 IEPE Mode:

1. AC Gain/Bandwidth Check: Set Test-Mode to "Test bus". Apply signal to the test bus input at the programmed cutoff frequency of the filter and measure the AC gain at the channel output. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level. Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.
2. AC Current: Set Test-Mode to "AC Current". Apply test bus signal at frequency of 0.1 times the programmed cutoff frequency. Measure signal at channel output and compute transducer + cable impedance (Z = (10E3/GAIN)*(Vout/Vin)
3. DC Offset Check: Set Test-Mode to "Short". Measure DC offset at channel output. The measured offset shall be compared to Yuma specified limits for pass/fail criteria.
4. Noise Check Input Short: Set Test-Mode to "Short". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.
5. Noise Check Excitation Off: Set Test-Mode to "EXC Off". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.

For 28334 Charge Mode:

1. AC Gain/Bandwidth Check: Set Test-Mode to "Shunt cal". Apply signal to the test bus input at the programmed cutoff frequency of the filter and measure the

AC gain at the channel output. Channels with programmed gains that are within 40dB of each other can be evaluated with the same calibration signal level. Channels should be tested in groups according to the programmed gain level. The measured gain shall be compared to Yuma specified limits for pass/fail criteria.

2. DC Offset Check: Set Test-Mode to "Run". Measure DC offset at channel output. The measured offset shall be compared to Yuma specified limits for pass/fail criteria.
3. Noise Check Input Short: Set Test-Mode to "Short". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.
4. Noise Check Run Mode: Set Test-Mode to "Run". Measure AC rms noise at channel output. The measured noise shall be compared to Yuma specified limits for pass/fail criteria.

Programmable Features for the 27104A/28104/28134 that shall be controlled by user interface via Ethernet on 28000 Backplane Interface Card:

Excitation Level
Excitation Sense
Autobalance
Input Coupling
Cutoff Frequency
Filter Bypass
Shunt Calibration Setup
Input Shield
Bridge Resistor Readback
Bridge Configuration Readback
Channel Gain Setup "Wizard":
    Fsr = Fullscale Input (Range) in MU
    Sensor = Sensor Sensitivity in mV/V/MU
    Reserve = Outband Reserve (Sets gain distribution around filter)
    Fsout = Fullscale output, in volts.
Test-Mode (Run, Exc, Zero Exc, Short, Test Bus)

Programmable Features for the 28454 that shall be controlled by user interface via Ethernet on 28000 Backplane Interface Card:

Excitation Level
Excitation Sense
Suppress
Input Coupling
Cutoff Frequency
Filter Bypass
2-wire/4-wire input setup
Input Shield
Channel Gain Setup "Wizard":
    Fsr = Fullscale Input (Range) in MU
    Sensor = Sensor Sensitivity in mV/mA/MU

Reserve = Outband Reserve (Sets gain distribution around filter)
Fsout = Fullscale output, in volts.

Test-Mode (Run, AC Current, IDRIVE, ISINK, IZERO, Short, Test Bus, Loop Resistance)

Programmable Features for the 28334 that shall be controlled by user interface via Ethernet on 28000 Backplane Interface Card:

IEPE Mode:

IEPE Current Level
Cutoff Frequency
Filter Bypass
Input Shield
Channel Gain Setup "Wizard":
Fsr = Fullscale Input (Range) in MU
Sensor = Sensor Sensitivity in mV/MU
Reserve = Outband Reserve (Sets gain distribution around filter)
Fsout = Fullscale output, in volts.
Test-Mode (Run, AC Current, IZERO, Short, Test Bus)

Charge Mode:

Cutoff Frequency
Filter Bypass
Input Shield
Charge Reset
Time Constant (Short/Long)
Channel Gain Setup "Wizard":
Fsr = Fullscale Input (Range) in MU
Sensor = Sensor Sensitivity in pC/MU
Reserve = Outband Reserve (Sets gain distribution around filter)
Fsout = Fullscale output, in volts.
Test-Mode (Run, Shunt Cal, Short, Test Bus)

System Features:

Monitor Bus Channel
28000-System Status
Report power supply voltages
Report internal temperature sensor readings
Report cooling fan status information
Overload Log
Clear overload/fault log file immediately prior to test.
Read and save overload/fault log file with the test data.
Calibration (May want password access to this since only required once/yr.)
Gain Adjust
Excitation Adjust
Offset Adjust